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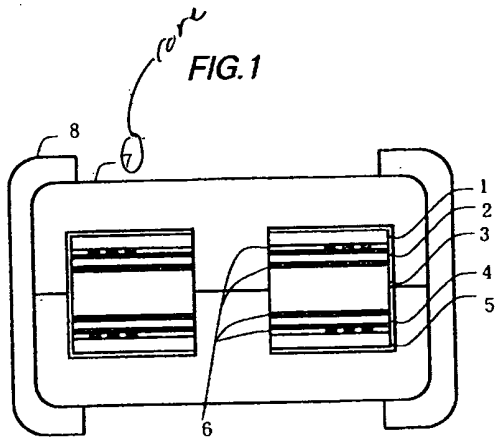
(54) FLAT TRANSFORMER

(57) The reference numeral (2) designates a primary coil substrate formed by printing a coil pattern with resist on a commercial double-sided printed-circuit board and etching it, and the reference numeral (4) designates a secondary coil substrate formed in the same process. The reference numerals (1, 3 and 5) designate insulating boards. A flat transformer is produced by interposing adhesive sheets between these boards (1 to 5), compressing and heating them to form a laminated plate, punching the laminated plate into a desired shape, fitting a core (7) into the laminated plate punched, and fastening it by means of fasteners (8). The transformer can have desirable dielectric strength depending on the materials and thicknesses of the insulation plates (1, 3 and 5).

FIG. 1



EP 0 782 154 A1

Description

BACKGROUND OF THE INVENTION

1. Field of the invention

The present invention relates to a flat transformer improved in dielectric strength, and such strength can be further arbitrarily set.

2. Brief Description of the Prior Art

For example, a flat transformer, disclosed in laid-open utility model publication No. 6-9110, comprises a primary coil on one surface and a secondary coil on the opposite surface of a both-sided printed substrate, and an opening formed inside the coils. Disclosed in laid-open utility model publication No. 6-9111 comprises a primary coil formed on a substrate and a secondary coil formed on another substrate, these being overlapped on each other, and a core formed through the inside of the secondary coil.

Further disclosed in laid-open utility model publication No. 5-343245 is a flat transformer, having a double-layered primary and secondary coils 73 and 75, formed, respectively, on one and on the other surfaces of an insulating layer 74, being encapsulated in an insulating layer 74, further covered with a magnetic layer 71.

According to the prior art above, indeed each flat transformer might be obtained, but the use of the printed board cannot provide a sufficient dielectric strength between the primary and secondary coils: the use thereof is possible for neither any of those including a switching source, DC-DC converter, nor a relay driver for the signal device. Also, any change of the leading-out wiring of the primary and secondary coils is difficult. And use of a new production technology must be utilized for that shown in FIG.14.

The present invention has been made to eliminate the problems above, and is to provide an improved flat transformer for which a dielectric strength can be arbitrarily designed and which is manufactured by the existing techniques.

SUMMARY OF THE INVENTION

In view of the foregoings, the invention provides a flat transformer having an insulating board interposed between printed boards, a core which is penetrated inside the coil, and an intermediate printed board with leading-out wirings for coils, and is more specifically featured in the following (1) to (8):

(1) A flat transformer comprising a primary coil formed on a printed circuit board; a primary coil board formed with an opening inside the primary coil; an intermediate insulating board superimposed on the primary coil and having an opening at the position corresponding to the opening formd in the primary coil; a secondary coil board superimposed on the insulating board, having a secondary coil formed thereon, and formed with an opening therein coincide with the opening formed in the insulating board; and a core for enclosing the primary, secondary and intermediate boards.

(2) A flat transformer according to claim 1, wherein the intermediate insulating board is formed of a printed circuit board having outwardly extending portions, on which one or more elements are mounted.

(3) A flat transformer comprising: a primary coil formed on a printed circuit board; a primary coil board formed with an opening inside the primary coil; an intermediate insulating board superimposed on the primary coil and having an opening at the position corresponding to the opening formd in the primary coil; a secondary coil board superimposed on the insulating board, having a secondary coil formed thereon, and formed with an opening therein coincide with the opening formed in the insulating board; and a core for enclosing the primary, secondary and intermediate boards; and a set of wirings for leading out from the prima ry and secondary coils are formed on the intermediate board.

(4) each of one end and the other end of the primary and secondary coils has an upper side terminal provided on the upper surface and a lower side terminal on the lower surface, respectively, and the upper and lower side terminals are electrically connected to each other through a hole formed throgh the board.

(5) A flat transformer according to claim 4, wherein at least one of the primary and secondary coil boards is formed of a plurality of boards laminated with each other.

(6) A flat transformer according to claim 4, wherein at least one of the primary and secondary coil boards is formed of a plurality of boards laminated with each other; and one and the other termials are interconnected by soldering.

(7) A flat transformer according to claim 4, wherein at least one of the primary and secondary coil boards is formed of a plurality of boards laminated with each other; one and the other termials are overlapped on each other, a space formed by the through hole is filled with solder.

(8) A flat transformer according to claim 3 to 7, wherein the intermediate insulating board is formed of a printed circuit board having outwardly extending portions, on which one or more elements are mounted.

By the foregoing structures, the dielectric strength can be arbitrarily established. Also, the wirings for introducing out of the coils are easily formed by the conventional techniques, and necessary components can be mounted on the intermediate printed board.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 is a schematic front view of embodiment 1 of the invention;
FIG.2 is a perspective view of FIG.1;
FIG.3 is a exploded fragmentary perspective view of FIG.1;
FIG.4a to 4c illustrate the prodction process of embodiment 1;
FIG.5a a schematic front view of embodiment 2;
FIG.5b is a fragmentary perspective view of FIG.5a;
FIG.6 is a perspective view of FIG.5a;
FIG.7 is a schematic front view of embodiment 3;
FIG.8 is a perspective view of FIG.7;
FIG.9 is a exploded fragmentary perspective view of FIG.7;
FIG.10a to c illustrate the prodction process of embodiment 3;
FIG.11a is a exploded fragmentary perspective view of embodiment 4;
FIG.11b is a fragmentary sectional view of FIG.11a;
FIG.12a is a schematic front view of of embodiment 5;
FIG.12b is a fragmentary perspective view of FIG.12a;
FIG.13 is a perspective view of FIG.12a; and
FIG.14 is a fragmentary sectional view of a conventional flat transformer.

DETAIED DESCRIPTION OF THE PREFERRED EMBODIMENTS

EMBODIENT 1

FIGS.1 to 4 include the embodiment, among which FIG.1 and 2 are a sectional and perspective views, respectively. For easy comprihension, the dimension is enlarged in the thickness direction than the horizontal direction in each figure including all of the other embodiments.

First, FIG.4(a) shows a commercially available glass-epoxy double-sided copper-laminated printed circuit board having a thickness of 0.1mm, and formed of copper layers 41, 42, a glass-epoxy layer 43, and having a through hole 44. A spiral coil pattern is formed by screen printing with resist ink on the upper surface of the board of FIG.4(a), and the resist is selectively removed by etching to form a coil 45. In the same manner, leads are formed on the lower surface, and ends of the coil and leads are interconnected with the through hole 44 (See numerals 2, 4 and FIG.4b).

In such a manner, the primary and secondary coil boards 2 and 4 shown in FIGS. 3 and 4, respectively, are formed. Further shown are an upper and a lower 2mm glass-epoxy insulating boards 1 and 5, as well as an intermediate insulating board 3 having a thickness of 0.3 mm. A bonding sheet is interposed between each of the boards, pressed and heated to form a laminate, and punched into the figure so as to comply with the E-shaped core 7.

The E-shaped core is coupled to the punched laminate, and fasteners 8 are fitted as shown in FIGS.1 and 2 to complete a flat transformer.

As described above, the transformer of the invention can be easily made by the conventional techniques, and the dielectric strength can be designed as desired by choice of the materials and thickness of the upper, lower and intermediate boards.

EMBODIENT 2

The embodiment 2 shown in FIG.5 uses a printed circuit board for the intermediate board, on which a needed IC or the like are mounted.

The primary coil board 51 is fabricated from a double-sided printed circuit board in the same manner as in the embodiment 1. One more coil 46 is formed on the lower surface of the board. A secondary coil board 53 is also in the same manner as the primary coil board 51. An intermediate insulating board 52 corresponds to the board 3 in embodiment 1, and has an outwardly extending portion as shown in FIG.6. On the intermediate board 62, wiring patterns are formed in the same manner as coil boards 51 and 53, and terminals 62 are formed on the portions extending from the board 52.

The boards 51, 52 and 53 are laminated with each other, a resinous coating layer for insulating is formed on each surface of the composite laminate, punched into necessary figures, an E-shaped core 7 is coupled, and finally fasteners 8 are fitted. The assembled transformer has the extending portion outside the board 52 mounted by ICs such as shown as an element 61, and the transformer is completed.

As forgoing described, the embodiment has substantially the same effect as the embodiment 1, and further necessary elements can be mounted.

EMBODIMENT 3

The embodiment 3 shown in FIGS.7 to 10 has a commercially available glass epoxy through-hole double-sided copper-laminated printed board having a thickness of 0.1mm shown in FIG.10(a) as its sectional view, including copper layers 410, 430, a glass-epoxy layer 430 and a through hole 440. Using a resist ink, the spiral coil pattern is printed on upper surface of the printed board of FIG.10(a), etched for selective removing, and the resist is removed to form a coil 450 and the upper side of terminal pads 470 and 480. The upper and lower sides of terminal pads 470, 480 are electrically interconnected by the through hole, which is formed by the conventional through hole plating method. The other end of the coil and an end of lead 460 are electrically connected by a through hole 440, and the other end of lead 460 is connected to terminal pad 480.

In such a manner, the primary and secondary coil boards 20 and 40 shown in FIGS.9 and 10 are formed,

including an upper and a lower glass-epoxy boards 10 and 50 of 0.2mm in thickness, and a glass-epoxy double-copper-laminated intermediate printed board 50 of 0.2mm in thickness. Also, on the intermediate board 30, terminal pads 490 and 500, leads 310 and 320, and external terminals 90 and 100 on its upper surface by the same manner as above, and also terminal pads 510 and 520, leads and external connections which are not shown are formed on the lower surface. Then, flow solder is placed on each of terminal pads 490, 500, 510 and 520. Adhesive sheets are interposed between the boards, respectively, leaving each terminal region, then pressurized, and heated to form a laminate, and punched into figures so as to coincide with the core 70. During heating, terminals 490 to 540 are soldered through reflow soldering process.

An E-shaped core 70 is coupled to the punched laminate, and fasteners 80 are fitted as shown in FIGS.7 and 8 to complete a flat transformer. The interconnection with the primary coil is achieved via external terminals 90, 100 formed on the upper face of intermediate board 30. Similarly, the connection with the secondary coil is via external terminals, not shown, formed on the lower face of the board 30.

Also, the transformer is formed by the conventional techniques, and dielectric strength can be designed as desired by the choice of materials. Specifications such as the turn ratio or the like can be freely changed.

EMBODIMENT 4

The embodiment 4 shown in FIGS.11a and 11b has a plurality of primary or secondary coil boards comprising a plurality of laminated coil boards. Here, it is shown a three-layered laminate as an example.

First, a insulating layer 1010 is formed on each board, that is, after forming the coil, an epoxy type organic insulator layer is formed by screen printing on the board leaving the terminal regions on both surfaces of the upper and lower.

Next, the boards each formed with the insulator layer 1010 are laminated so as to register the terminal regions 470 and 480, wherein each terminal 480 and each 490 are successively soldered to each other. Also, after laminated, by means of flowing solder within the hole 1000, the terminals may be electrically connected to each other.

As a result, the laminated plurality of coil board structure provides a connection in which each of coils is in the state of connected in parallel, and, therefore, the copper loss I^2r (r: the d.c. resistance component) in the coil becomes I/nI^2r, and leads to reduction of energy loss and heat generation due to the copper loss.

As described, by successively connecting the terminals by solder, a plurality of coil boards are easily laminated on each other, and, by connecting these in parallel, the energy loss due to copper loss can be reduced.

EMBODIMENT 5

The embodiment 5 is shown in FIGS.12(a) and 12(b), on which necessary elements such as ICs can be mounted.

A primary coil board 610 is fabricated from a commercially available double-sided printed-circuit board by the same method as embodiment 3. FIG.12(b) shows another coil 450-2 also formed on the lower surface of the board in the same manner. The coil 450-1 formed on the upper face is with its one end connected via through hole 660 to terminal 670 on the lower face, and with the other end connected via through hole 680 to the end of the lower coil 450-2, while the other end of coil 450-2 is connected to a lower terminal 690. A secondary coil board 630 is fabricated also in the same manner as primary board 610. An intermediate coil board 620 has regions both-sidely extending from the primary and secondary boards 610 and 630, and has lead patterns for primary and secondary coils and necessary wiring patterns formed in the same manner as the coil boards 610, 630, and also a number of terminals 720 are formed on the outwardly extending regions.

Each of boards 610, 620 and 630 is laminated in the same manner, a resinous coating layer 650 for insulation is formed on each surface of the resulting laminate, punched into necessary figures, an E-shaped core 70 is coupled, and finally fasteners 80 are fitted. The assembled transformer has the above-mentioned extending regions mounted by ICs such as shown as an element 710, and the transformer is completed.

As described, the embodiment provides the same effect as embodiment 3, and further provides mounting of a necessary element.

VARIATIONS

Instead of punching to form the figures and forming the through holes, the boards may be in advance punched into necessary figures, and thereafter, holes, coils, leads and terminals may be formed: then the primary and secondary printed boards are mounted on the intermediate board.

As described above, the invention provides a flat transformer having a feature capable of arbitrarily designing the dielectric strength, and another feature, in addition to the dielectric strength, capable of easy modification of the specifications such as the turn ratio, and of the leading-out wirings of the primary and secondary coils.

INDUSTRIAL UTILITY

As described above, the flat transformer of the invention is useful in use for any of those including a switching source, DC-DC converter, and a relay driver for the signal device.

Claims

1. A flat transformer comprising:

   a primary coil formed on a printed circuit board;
   a primary coil board formed with an opening inside said primary coil;
   an intermediate insulating board superimposed on said primary coil and having an opening at the position corresponding to said opening formd in said primary coil;
   a secondary coil board superimposed on said insulating board, having a secondary coil formed thereon, and formed with an opening there in coincide with said opening formed in said insulating board; and
   a core for enclosing said primary, secondary and intermediate boards.

2. A flat transformer according to claim 1, wherein said intermediate insulating board is formed of a printed circuit board having outwardly extending portions, on which one or more elements are mounted.

3. A flat transformer comprising:

   a primary coil formed on a printed circuit board;
   a primary coil board formed with an opening inside said primary coil;
   an intermediate insulating board superimposed on said primary coil and having an opening at the position corresponding to said opening formd in said primary coil;
   a secondary coil board superimposed on said insulating board, having a secondary coil formed thereon, and formed with an opening there in coincide with said opening formed in said insulating board;
   a core for enclosing said primary, secondary and intermediate boards; and
   a set of wirings for leading out from said primary and secondary coils are formed on said intermediate board.

4. A flat transformer according to claim 3, wherein each of one end and the other end of said primary and secondary coils has an upper side terminal provided on said upper surface and a lower side terminal on said lower surface, respectively, and said upper and lower side terminals are electrically connected to each other by a through hole formed throgh said board.

5. A flat transformer according to claim 4, wherein at least one of said primary and secondary coil boards is formed of a plurality of boards laminated with each other.

6. A flat transformer according to claim 4, wherein at least one of said primary and secondary coil boards is formed of a plurality of boards laminated with each other; and one and the other termials are interconnected by soldering.

7. A flat transformer according to claim 4, wherein at least one of said primary and secondary coil boards is formed of a plurality of boards laminated with each othe; one and the other termials are overlapped on each other, a space formed by said through hole is filled with solder.

8. A flat transformer according to claim 3 to 7, wherein said intermediate insulating board is formed of a printed circuit board having outwardly extending portions, on which one or more elements are mounted.

FIG.1

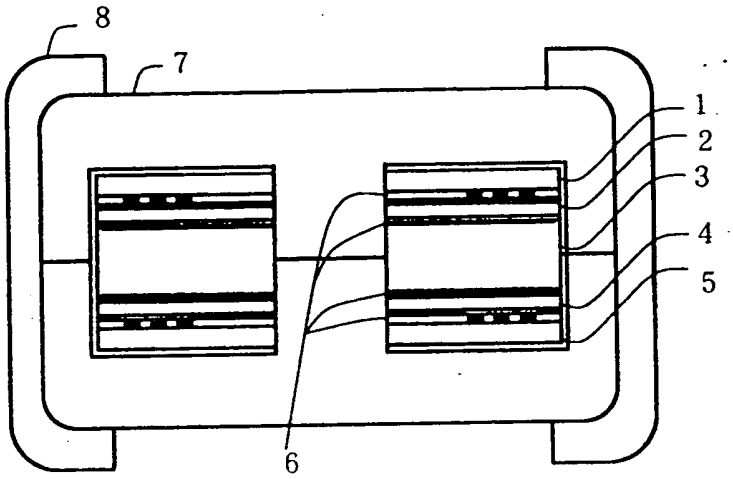


FIG.2

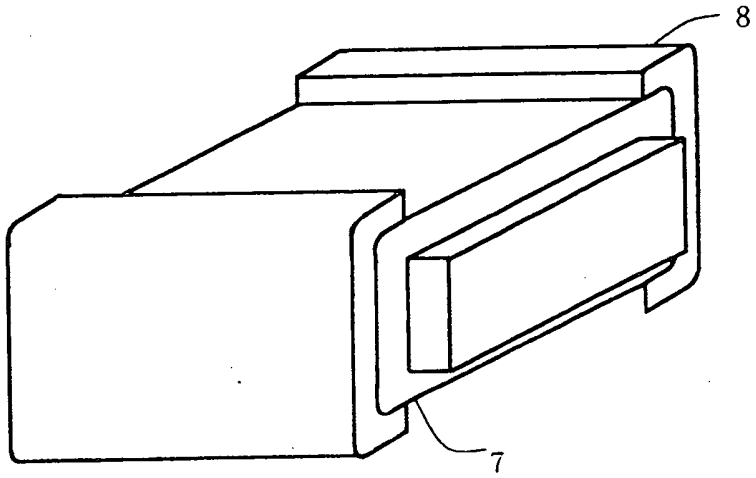


FIG.3

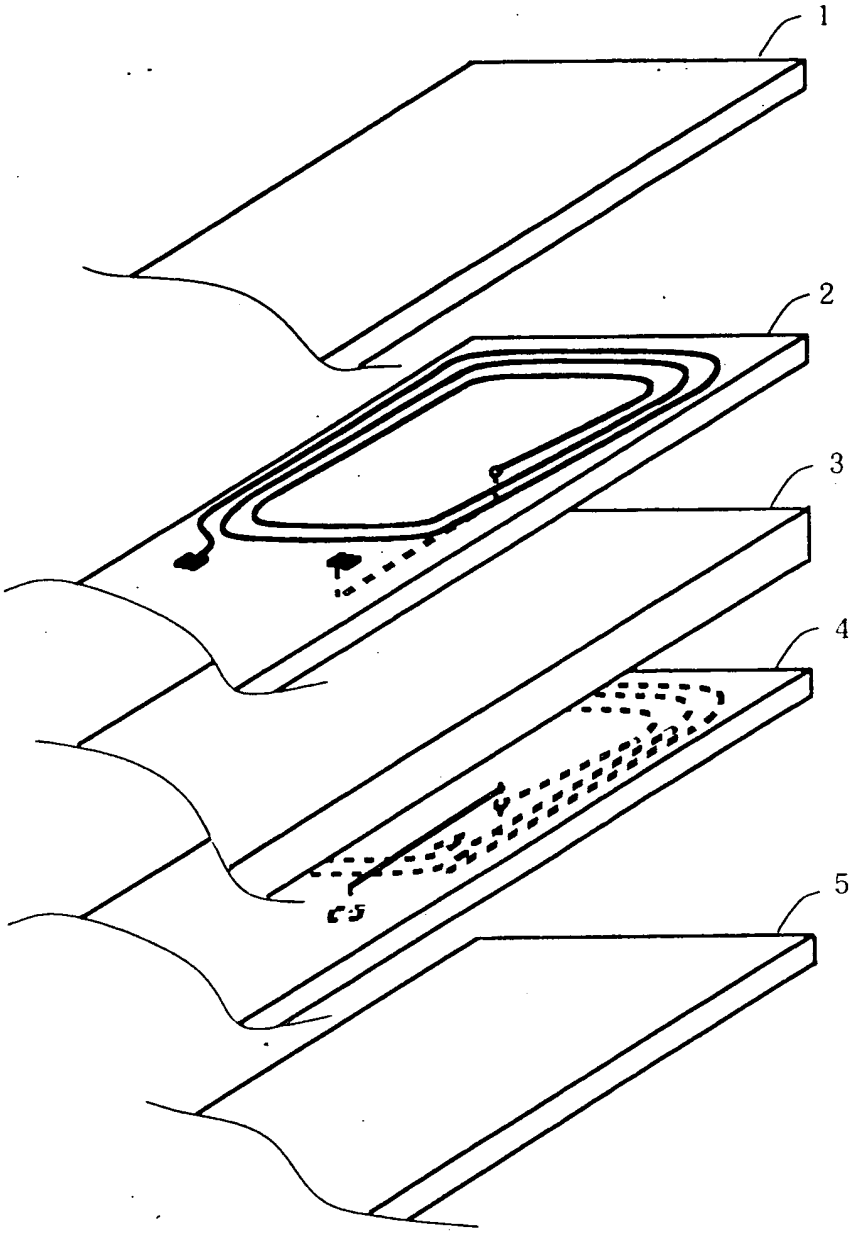


FIG.4 (a)

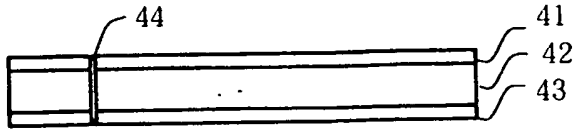


FIG.4 (b)

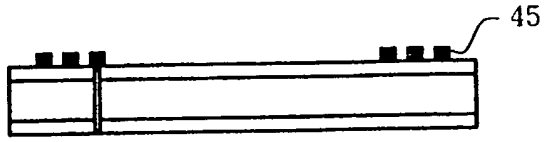


FIG.4 (c)

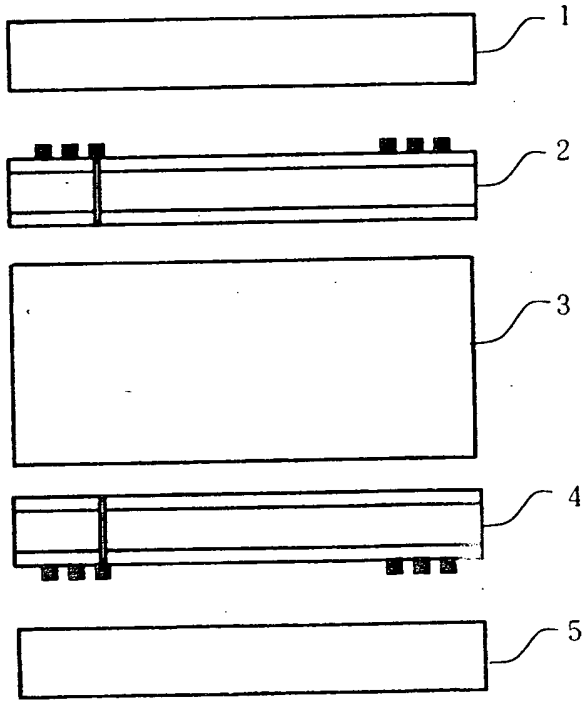


FIG.5 (a)

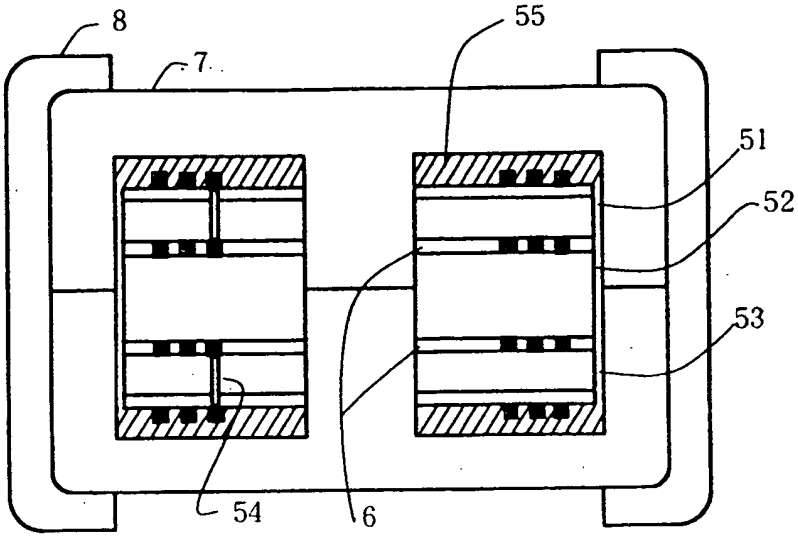


FIG.5 (b)

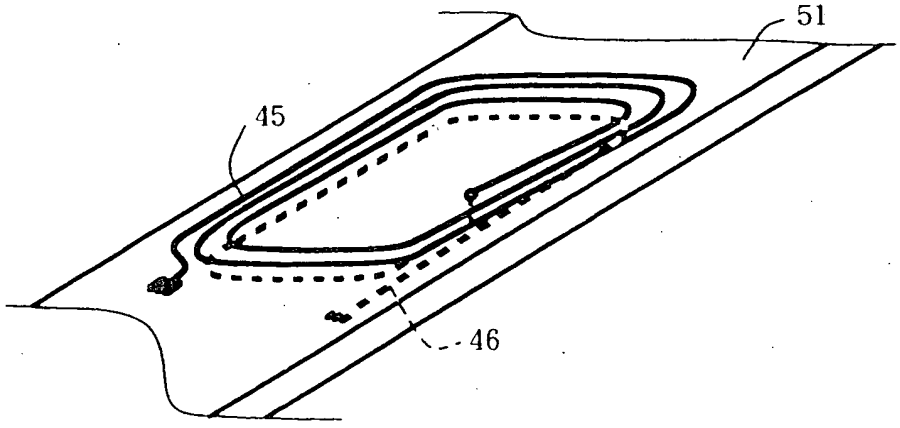


FIG.6

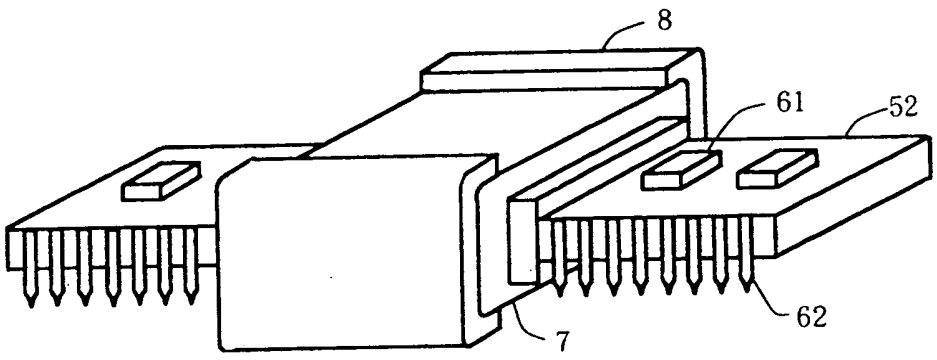


FIG.7

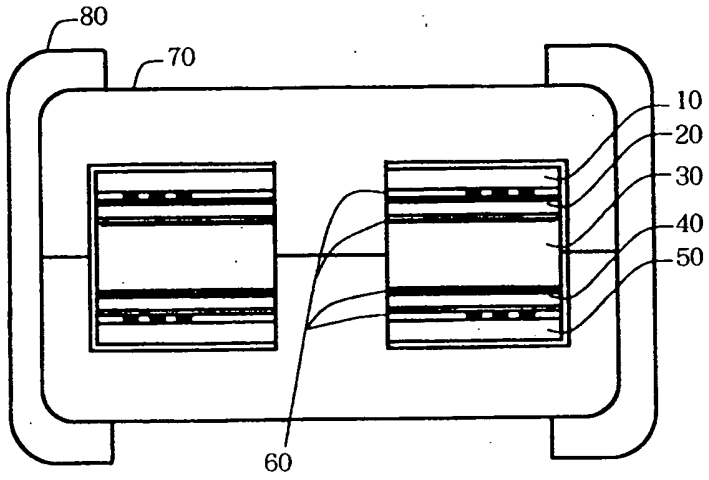


FIG.8

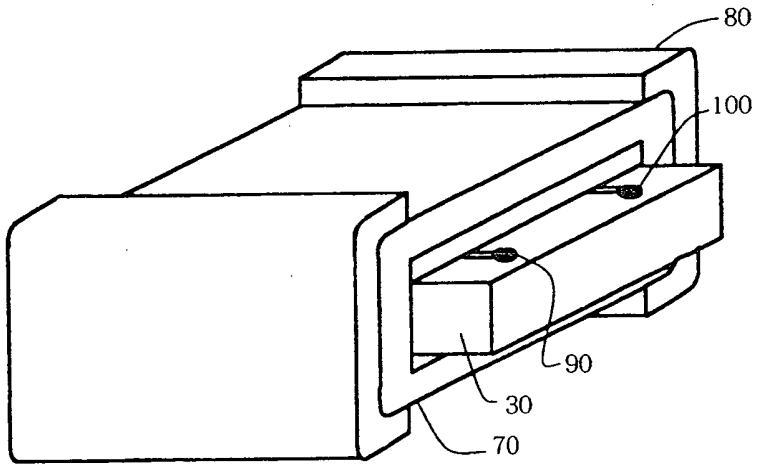


FIG.9

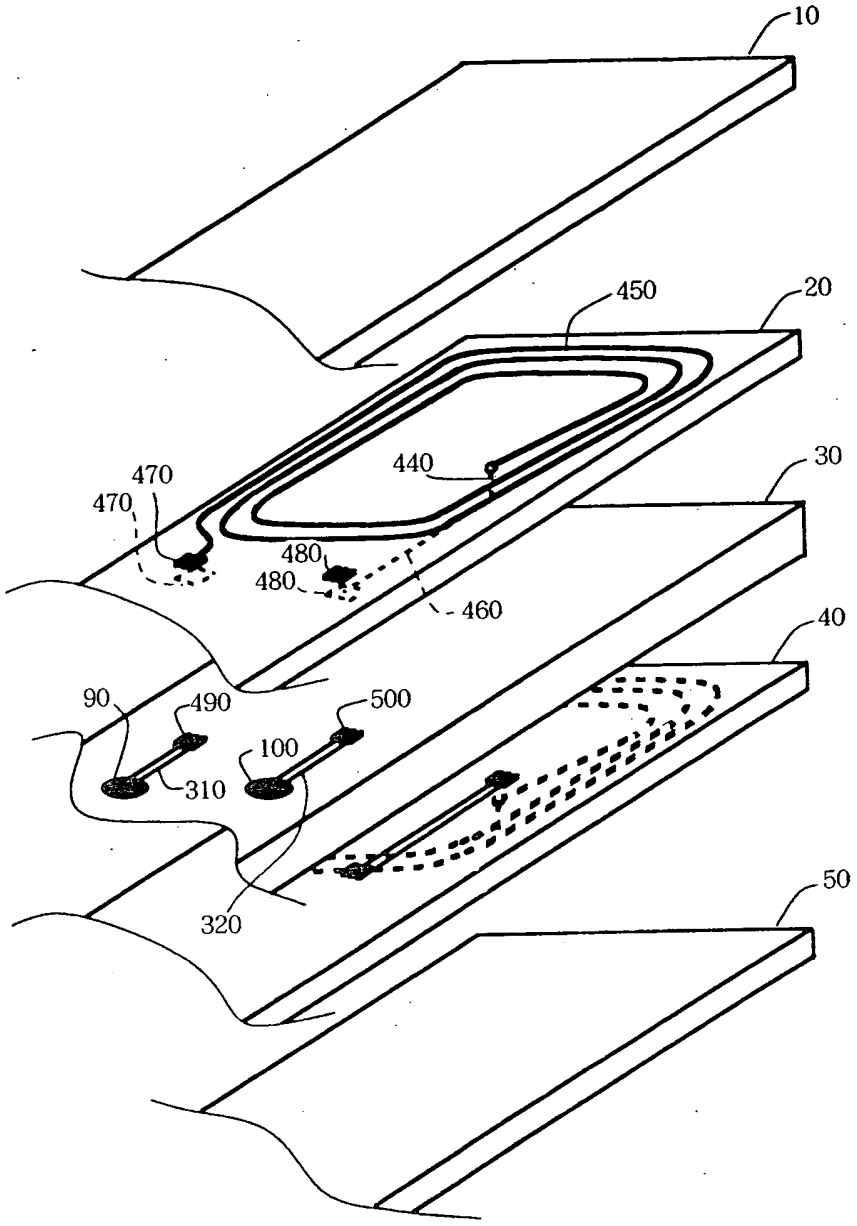


FIG.10 (a)

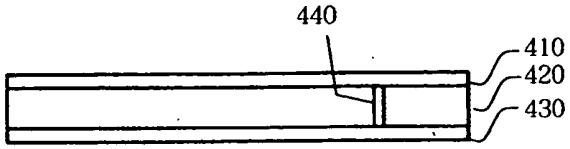


FIG.10 (b)

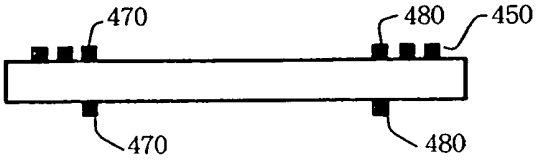


FIG.10 (c)

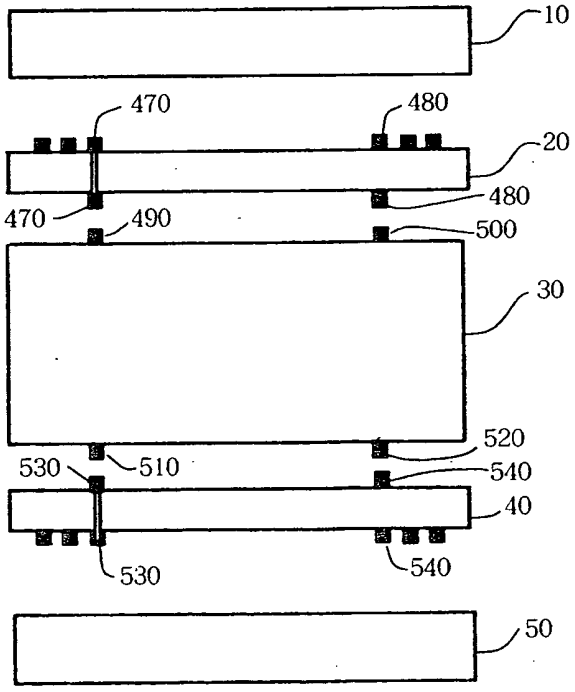


FIG.11 (a)

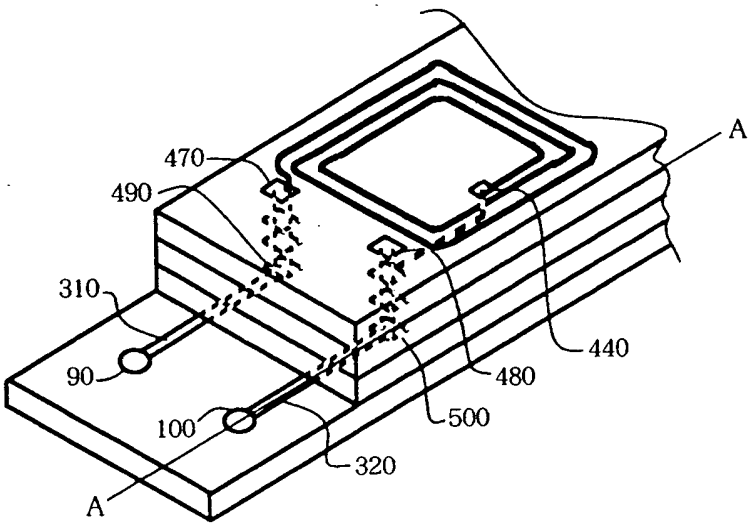


FIG.11 (b)

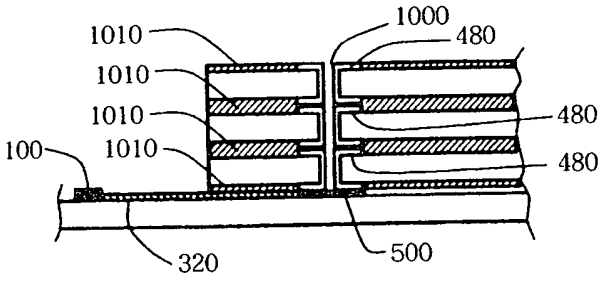


FIG.12 (a)

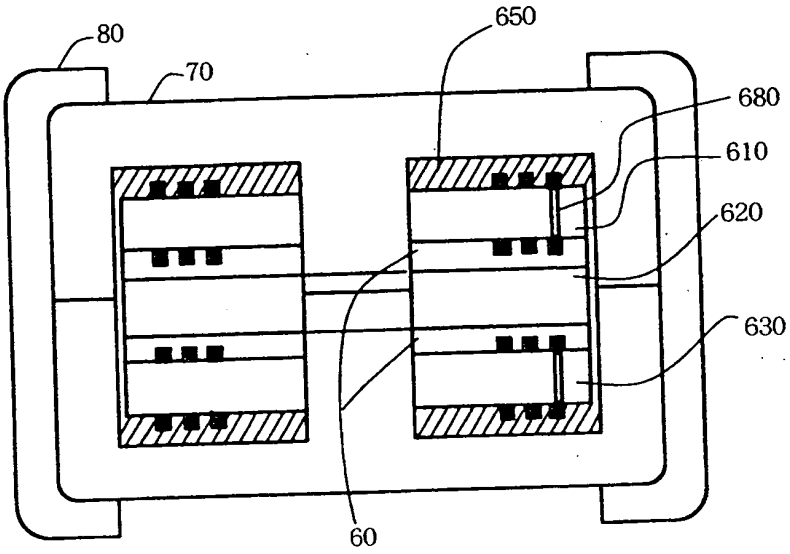


FIG.12 (b)

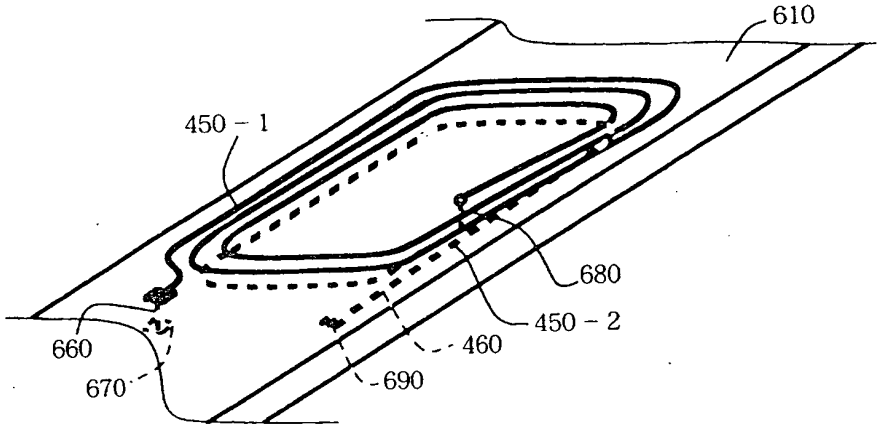


FIG.13

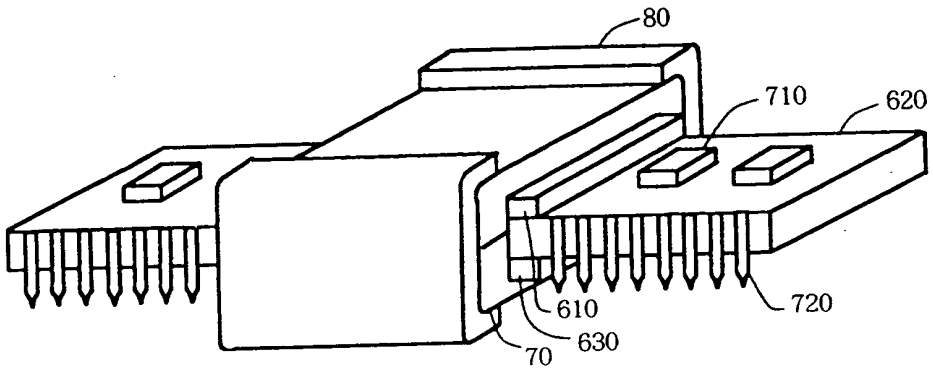
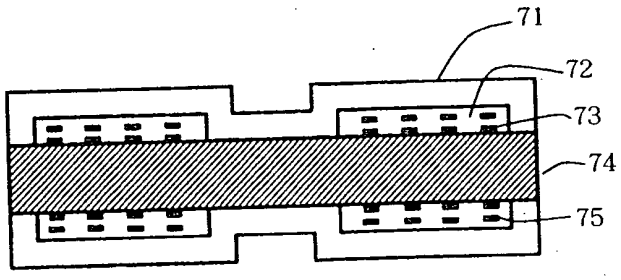


FIG.14
PRIOR ART



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP96/01597

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl^6 H01F19/00, H01F17/00, H01F30/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
Int. Cl^6 H01F19/00, H01F17/00, H01F30/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926 - 1996
Kokai Jitsuyo Shinan Koho 1971 - 1996

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP, 3-183106, A (Sanken K.K.), December 12, 1989 (12. 12. 89) (Family: none)	1 2, 3, 4, 5, 6, 7, 8
A	JP, 63-224209, A (Fuji Electric Co., Ltd.), March 12, 1987 (12. 03. 87) (Family: none)	1, 3
A	JP, 5-275239, A (Murata Mfg. Co., Ltd.), October 22, 1993 (22. 10. 93) (Family: none)	3
A	JP, 4-137602, A (Toshiba Lighting & Technology Corp.), May 12, 1992 (12. 05. 92) (Family: none)	3, 4, 5, 6, 7, 8

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
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